MIT LIBRARIES
3 9080 00701522 2

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HD28
.M414
no.3247-
91

DEWEY

MAR 11 1991

WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

Model-Supported Case Studies for Management Education

Alan K. GRAHAM[+], John D.W. MORECROFT[§], Peter M. SENGE[+], and John D. STERMAN[+]

[+]MIT School of Management, E52-562, Cambridge, MA 02142-1347
[§]London Business School, Sussex Place, Regent's Park, NW1 4SA, London, UK

MIT School of Management Working Paper BPS-3247-91 February, 1991

MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
50 MEMORIAL DRIVE
CAMBRIDGE, MASSACHUSETTS 02139

Model-Supported Case Studies for Management Education

Alan K. GRAHAM[+], John D.W. MORECROFT[§], Peter M. SENGE[+], and John D. STERMAN[+]

[+]MIT School of Management, E52-562, Cambridge, MA 02142-1347
[§]London Business School, Sussex Place, Regent's Park, NW1 4SA, London, UK

MIT School of Management Working Paper BPS-3247-91 February, 1991

M.I.T. LIBR
MAR 1 1 1991
RE

Model-Supported Case Studies for Management Education*

Alan K. GRAHAM[+], John D. W. MORECROFT[§], Peter M. SENGE[+], and John D. STERMAN[+]

[+] Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA 02139, USA

[§] London Business School, Sussex Place, Regent's Park, NW1 4SA, London, UK

Abstract

There is growing interest in combining computer simulation models with conventional case studies to create learning environments for management education. 'Model' here denotes an endogenous theory of business dynamics, a simulation microworld, and not merely a spreadsheet or multimedia computer environment. Model-supported case studies promise improvement in strategic thinking skills and better integration of modeling with policy and strategy formation. Two examples are presented (People Express Airlines and the Intecom PBX) to show explicitly how cases and system dynamics models are combined and used. Finally, we explore research questions that arise in conjunction with such work: 1) how to teach effective inquiry skills, 2) how to teach conceptualization skills, and 3) how to enhance the ability to transfer insight to new situations.

Keywords: Management education, case method, system dynamics, simulation, microworlds

---

* Forthcoming, **European Journal of Operational Research**

I. Introduction: The role of models in case-based education

To understand where system dynamics models, especially models-with-cases, may contribute to management education, consider first how business policy and strategy are traditionally taught. Case studies are the cornerstone. The objective is to develop skills to "think strategically", "view the business as a whole" or "adopt the perspective of the general manager". A typical case is 20-30 pages in length and contains about 10,000 words of text, plus diagrams and numerical information, often financial reports and market data. Usually cases provide a brief history of the company, a description of its products or services and descriptions of competitors. Depending on the purpose the case may describe details of manufacturing, marketing, and distribution, or delve into human resource policy, systems of administration and control, organizational structure, company traditions and values, management style, leadership or personalities. Case teachers use such descriptive and numerical information to trigger classroom discussion about the business, its administration and its strategic options. But how and what do students learn?

Case teachers do not teach answers. They offer instead frameworks which guide class discussion and help learners organize case information and form opinions. For example, Porter's (1980, 1985) competitive analysis framework is now widely used to guide discussion about business unit competitive strategy. Whether the subject is supercomputers, water meters, airlines or fashion watches, Porter's framework prompts critical thinking about questions such as 'is this an attractive industry to be in?; what stops competitors from entering?; what motivates customers to buy?; are suppliers or distributors in a position to siphon off the firm's profits?'. It encourages close examination of the activities upon which a company builds and sustains its competitive edge. The framework provides the case teacher with a checklist of thought-provoking questions, and graphics with which to collect and select participants' comments.

At the end of a typical case discussion, students typically see several chalk boards of material, based mostly on their own comments, with a visual layout controlled by the teacher. What has been the pedagogical value of the process? First, learners feel involved – their opinions and comments have received attention. Second, the instructor has imposed discipline on the

discussion through the use of the framework, but not a heavy discipline. The framework provides broad brush questions and accommodates a wide range of comments. With practice and perhaps some lectures on competitive analysis, learners begin to be able to use the framework. Third, the class as a whole has a shared focus for debate – the information displayed on the board. (The same learning benefits occur when strategic frameworks are used to organize management team discussion of live business problems, as in Morecroft 1988b).

However the case method has limitations. Chief among these is the impossibility of testing hypotheses the participants offer as to the effects of alternative actions. To evaluate the consequences of policies other than those described in the case, and even to attribute the actual outcomes to particular causes, one must conceptualize a model of the system described in the case and perform mental simulations to infer its likely dynamics. But people face formidable problems in formulating appropriate models of complex environments and correctly relating system structure to behavior. Extensive research in behavioral decision theory and other fields documents the bounds on human rationality which create persistent judgmental biases and systematic errors in complex settings (Simon 1979, Kahneman, Slovic and Tversky 1982, Hogarth 1987).

Research in dynamic decision making and system dynamics shows that environments characterized by multiple feedback processes, side effects, time delays, and nonlinearity are particularly troublesome. Experiments show students and managers alike suffer from persistent "misperceptions of feedback" which result in extremely poor performance and slow or no learning (Sterman 1989a, 1989b, Senge and Sterman 1991, Diehl 1989, Kleinmuntz 1985, Brehmer 1990). The very skills required for effective learning in the case method are precisely those for which the human mind is ill-suited. The result is an inability to assess the validity of alternative strategies. In the case method one cannot separate insight from hindsight.

We believe simulation methodologies such as system dynamics help overcome the misperceptions of feedback which plague managers in the real world. System dynamics offers a framework for conceptualizing complex business (and other) situations, tools to identify the physical, organizational, and decision making structure of the systems, and simulation methods to infer

correctly the dynamics of these structures. In the following, we define a model-supported case study as a traditional case supported by a simulation model and/or modeling tools. By model we mean a behavioral theory of the feedback structure of the business setting which endogenously generates the problematic behavior described in the case. We do not consider cases supported by spreadsheets portraying the financial reports or other exhibits typically found in the back of a case. Nor do we consider cases in which the written text is supplemented or replaced by hypertext, videodisc, or multimedia technologies. These developments, while promising, do not address what we consider to be the central deficiency of the case method – the need for a simulated microworld which can provide realistic feedback to the learner on the consequences of alternative strategies. Note that we are not proposing the use of simulation models to provide "the answers" but as the cornerstone of an environment for learning about business dynamics. But for which aspects of business strategy curricula may such model-supported cases be useful?

Business policy and strategy courses cover topics in several dimensions, from strategies for the business unit/single business firm to the complex multi-divisional, multi-business firm. Issues range from the competitive and economic forces that shape strategic options to administrative and organizational constraints. Different frameworks develop different dimensions of strategic thinking. For example, McKinsey's "7 S" framework (a simple diagram showing 7 labelled and interlinked bubbles, Hax and Majluf 1984, pp. 94-96) helps trigger thinking about constraints on strategy – the fit between strategy and structure: do the firm's structure, employees, administrative systems, capabilities, knowledge base, organization structure, and culture support or hinder the strategy? Portfolio frameworks like the famous growth-share matrix of the Boston Consulting Group (Hax and Majluf 1984, Chapter 7) can guide discussion about corporate portfolio management – what businesses should a firm be in, how should corporate resources be allocated, what criteria should management use to evaluate and compare business unit performance, how should one segment the business for strategic planning purposes?

Model-supported case studies retain a strong process flavor. They stimulate and guide discussion, without stifling it. Like other frameworks, the model, along with the systems thinking

concepts which accompany it, shapes the case discussion. In addition models-with-cases allow "what-ifs" and role-playing in a feedback system which captures side-effects and other attributes of reality, adding important new process dimensions which cannot be replicated in the conventional case method. Learners are drawn into the case by taking the role of key decision-makers, exercising choice and judgement, and experiencing the consequences of their actions.

System dynamics models are particularly suited to understanding the coordination between strategy and operating policies – how to distinguish goals from strategies designed to achieve goals; how to design a set of policies and programs that support rather than frustrate strategic objectives. In addition, at the business unit level, models can illuminate the administrative issues (goal formation, incentives, motivation, time allocation, information availability, etc.) as well as market, economic, and political environment issues. Models-with-cases provide an important link between strategy formation and implementation at the operations management level. Models-with-cases do not, however, have across-the-board applicability to all strategic issues. Rather, model supported cases make unique and much needed contributions to the development of strategic thinking skills for operating policy design (but see Merten, Löffler & Wiedmann 1987 for one example of system dynamics used to support a multinational firm's dynamic portfolio management).

2. Case Study: People Express Airlines

2.1 The Rise and Fall of People Express.

One of the most popular Harvard Business School cases of recent years describes People Express Airlines (Whitestone 1983). People Express went from startup in 1981 to the fifth-largest US airline and annual revenues in excess of $1 billion by 1986. Behind its meteoric rise were deep discount prices, making air travel competitive with the bus on many routes, a host of innovative "new management" policies, such as universal employee ownership, work teams, and job rotation, and a charismatic founder, Don Burr. But PE's spectacular early success was matched by equally spectacular failure. In the first nine months of 1986 the firm lost $245 million, and, in September 1986, the firm was purchased by Texas Air for only $125 million (Figure 1; Table 1). The People Express case is widely used to examine a broad range of issues in growth management, industry

deregulation, human resources, organizational structure, and executive hubris.

2.2 A Strategy Model.

The People Express Management Flight Simulator (Sterman 1988) is an interactive simulation game based on a system dynamics model of the firm. Interestingly, Sterman developed the first version of the model before the demise of the company in 1986 (helping to address concerns about the prospective use of models). The model integrates the operations, human resources, organizational structure, and philosophy of People Express with the structure of the US air-travel market and competitive environment of the early 1980s (figure 2). In addition to "hard" variables such as fleet size, flight schedule, aircraft capacity and a full set of financial reports, the model includes a variety of "soft" variables including hiring and training lags, the effects of overtime, fatigue, and stock price changes on morale, productivity, and employee turnover, and the effects of service quality on reputation and customer demand. The model differentiates between the quality-sensitive and price-insensitive business travelers and the price-sensitive, quality-insensitive discretionary travelers (what People Express veterans called the backpackers). Following standard marketing models, demand is driven by both advertising and word of mouth. Potential customers respond to the flight schedule and availability of service, fares, service quality, and "service scope" (the range of services offered). The model includes competitor price response based on PE's market share and fares. The stock price varies endogenously as PE's earnings, growth, and financial position change.

2.3 The Management Flight Simulator and Workshop

For educational purposes, the model has been converted into a decision-making simulation, the "People Express Management Flight Simulator", which puts each participant in the role of the top management. As in a traditional case format, participants prepare by reading the Harvard Business School case and a twenty-page briefing book summarizing the assumptions of the model and giving instructions on use of the software (Sterman 1988). Rather than merely discussing the reasons for the failure of People Express and offering untestable suggestions for strategies which might have succeeded, the Management Flight Simulator allows, indeed requires, participants to

formulate and implement their own strategies for the success of People Express. Each quarter-year participants must set fares and decide how many planes to buy, how many customer service managers (CSMs) to hire, how much to spend on marketing, and what scope of services to offer. (The simulation is implemented for the Macintosh computer. The model was developed in STELLA (Richmond, Vescuso, and Peterson 1987). The gaming interface is implemented in MicroWorlds, a simulation and gaming package developed by and available from Ernst Diehl of the MIT System Dynamics Group.) After entering their decisions for the quarter participants receive feedback on the results and must make decisions for the next quarter (Figure 3). The participants may go bankrupt or may grow to dominate the market.

Instructors at different institutions have developed many different ways to use the simulator. One format, developed by Sterman, has proven effective in workshops ranging from a few hours to several days. The workshop begins with a short review of the history of People Express. Next, students view a brief video clip dating from 1985 in which Don Burr speaks about his philosophy (Harvard Business School 1985), a clip which invariably stimulates vigorous discussion including issues of leadership and underlying values such as the purpose of a corporation (to make money, or, as Don Burr argues, to "make a better world"). The workshop here resembles a traditional case discussion, with participants offering their own theories to explain the failure of the firm. The discussion concludes with participants' suggestions of strategies which would have succeeded. It is critical for people to "go public" with their own suggestions here so they can compare their initial thoughts to those they develop after managing the simulated company (see Senge and Sterman 1991 for discussion). Even in groups as large as 250, the introductory phase, including the video, can take as little as an hour. Next participants are instructed in the use of the simulator. While the model is quite complex, the interface for the simulator is straightforward and requires no prior training or computer skills. Students and senior managers without any computer experience have been able to begin testing their own strategies for People Express in about twenty minutes. No special training is required for the instructor.

During the next few hours participants run their own airlines. Teams of two or three are

recommended to encourage debate and discussion of proposed strategies. The teams are encouraged to experiment systematically rather than always trying to maximize performance. Indeed, their first task is to agree on what they seek to accomplish (profits were the last of six major goals People Express sought to achieve). In the course of a few hours most teams are able to run the simulator several times. Nearly all teams experience bankruptcy at least once; by the end of the session nearly all also find a successful strategy. Participants are also encouraged to critique the model. To encourage such critical reflection, Sterman tells participants "this model is wrong". By explicitly identifying the simplifying assumptions and limitations of the model participants are moved to consider how their strategies would perform in the real world. Telling participants up front that the model is imperfect avoids adversarial debate about the merits and shortcomings of the simulation model and stimulates joint inquiry into the realism of the results.

Successful game play, however, is not enough. The workshop continues with discussion to elicit and articulate the lessons learned by the participants. In our experience the level of discussion is always much deeper than the case discussion at the start of the workshop. First, participants appreciate how difficult it is to manage such a system. Many express admiration for Don Burr's achievement despite the eventual sale of the company. Participants are more aware of the side effects, counter-reactions, time delays, and tradeoffs they face. The simulator does seem to be effective in increasing participants' sensitivity to the feedback structure and dynamics of the system. Suggestions for strategies are also more specific and implementable than those typical of the earlier case discussion.

To illustrate, it is common in the initial discussion for participants to suggest that People Express could have succeeded if they "maintained service quality". While perhaps desirable, "maintaining service quality" is a goal and not an actionable, implementable policy. After playing the game, participants articulate a more highly developed understanding of the time lags and counterpressures which may frustrate quality improvement programs. For example, in the context of People Express' rapid growth, hiring still more customer service managers (CSMs) to increase the organization's service capacity and counteract the decline in customer service further dilutes the

average skill and experience level of the workforce and requires experienced CSMs to spend more time in hiring and training and less in serving the customers. Declining service quality reduces morale and productivity, increasing turnover and further reducing service resources; the remaining CSMs may have to work additional overtime, leading to fatigue, burnout, turnover, and falling productivity, further exacerbating quality problems. If lagging productivity causes profits to fall and the stock price drops, the plunging net worth of the employees further hurts morale and increases turnover, in a vicious cycle. Even if service improves, given People Express' low fares, the result is only to attract still more would-be customers, causing even more busy signals on reservations lines, congestion in the terminal, overbooking, and other problems which drag service quality down again. Participants are rarely able to identify and integrate all these effects without experiencing them as they run their own airline in the simulator. After playing they are much better able to do so. They volunteer examples of similar dynamics from personal experience or other cases, thus developing understanding of an important generic structure and successfully transfering the lessons to other cases.

In some workshops Sterman uses the STELLA model embodied in the Flight Simulator to test strategies suggested during the discussion. These tests, projected for all to see as a decade long simulation unfolds in seconds, further cement the business lessons and systems thinking principles. In workshops designed to teach systems thinking as well as principles of business strategy, participants often go on to map the feedback structure of People Express through causal loop diagrams (on causal diagramming techniques see Richardson and Pugh 1981). The simulated experience of running the company tends to produce causal maps of much higher quality compared to those of similar groups who draw only on the case and discussion.

2.4 The Lessons

A case as rich as People Express can be used to illuminate many issues. The core issues center around the reasons such spectacular success so quickly became failure. Was it their innovative philosophy, human resource policies and organization design? Was it external competitive reaction? Was it top management ego? And, most importantly, how transferable are the lessons of

the case to other firms and industries?

At the heart of People Express' demise were inherent contradictions between its innovative human resource policies on the one hand and its pricing policies and rapid growth on the other. Don Burr wanted to demonstrate "a new way to run an airline," to show that a non-hierarchical structure, democratic principles, trust, and shared economic risks and rewards would produce a vastly more productive organization. He also was intent on becoming a major player in the airline business in a few years, to which end he offered exceedingly low fares, attracting customers in droves and driving breakneck growth from 3 to over 75 aircraft in just 5 years.

Don Burr's creative innovations did indeed produce an organization much more productive than the industry average. Coupled with the savvy purchase of used aircraft, use of then-ignored Newark as a hub, and no-frills service, he created an organization which was profitable at fare levels less than half of the competition. However, the rapid growth – more than 100% per year – caused by the low prices was inconsistent with a hiring process which carefully screened prospective employees for their fit to a radically new culture (slowing the staffing process) and an organization in which individuals were largely self-managing and rotated among different jobs (slowing the learning process). The result was staffing shortages, skill dilution due to inadequate time to develop management skills, falling service quality, declining morale, and burnout. People Express soon had overloaded reservations lines, high rates of lost luggage, delayed flights, the highest overbooking rates in the industry, and led the industry in consumer complaints. When the competition, prodded by the success of People Express and similar post-deregulation startups, finally developed the capability to match PE's low fares, People's sole remaining competitive advantage disappeared, ridership fell, and losses mounted, ultimately forcing the sale to Texas Air to stave off bankruptcy.

The simulation experience allows people to test other theories about the collapse of the company. For example, a common interpretation of PE's failure cites as the cause the innovative use of information technology by competitors, notably American Airlines. The SABRE system allowed American to match PE's fares despite higher costs (through yield management) and to

dominate the chief distribution channel (travel agents), thus negating PEs price advantage while still offering full service and higher quality. The effect of yield management was indeed dramatic. However, the feedback framework developed through the simulator experience encourages students to see this stunning technological development as an endogenous competitive reaction to the price advantage and rapid growth of People Express rather than an unforeseen external event. Students are motivated to test this theory in the simulation by asking, for example, what might have happened if American's investment in yield management had failed or been delayed (higher competitor prices would have further increased PE's demand, pushing service quality still lower and increasing PE's vulnerability to price competition; competitors would have worked harder to find other ways to match PE's fares, etc.). Participants begin to design more effective strategies by asking how PE's own strategy provoked the competitors' response. Through such experimentation many propose a strategy of somewhat higher fares to control excessive growth of demand, thus preventing quality erosion and vulnerability to price competition caused by loss of the price-insensitive but quality-sensitive business traveller. They go on to debate issues such as whether slower growth and higher prices would reduce or delay price cuts by competitors; whether slower growth would have given PE management the time to scan the competitive environment and identify these threats earlier; whether slower growth and higher margins would have provided PE with the resources to develop their own yield management system in time (PE's own efforts to develop a yield management system were plagued with problems – their system came on line the day Don Burr announced the sale to Texas Air [Don Burr, personal communication]). The simulator provides ways to test alternative theories, to reach a deeper understanding of the source of difficulty, and, most importantly, of management's leverage in preventing or influencing the response of actors such as competitors who seem at first glance to be outside management control.

2.5 Uses, Users, and Student Evaluation

The People Express Management Flight Simulator was first used at the MIT Sloan School of Management in September 1988 as a day in a week-long orientation program for incoming master's students. Figure 4 summarizes the student evaluations. The People Express workshop

was the highest rated session of the orientation program. The workshop has been repeated each year; in 1990 involving 250 students and 90 Macintosh computers. It is also used in courses on service operations management, behavioral decision-making, and system dynamics.

The People Express Management Flight Simulator has now been adopted by dozens of universities including the Harvard Business School, University of Texas, Stanford Law School, London Business School, Notre Dame, University of Southern California, Queen's University (Ontario), IMD (Lausanne), IESA (Venezuela) and many others around the world. It is used for both orientation programs and in courses as diverse as strategy, marketing, operations management, simulation modeling, organizational behavior, human resource management, and economics. It has also seen wide use in management training at all levels of management in industries including air travel, telecommunications, computers and manufacturing.

The success of the People Express Management Flight Simulator has led to the development of additional model-supported cases, including cases on strategy for durable goods such as consumer electronics, toys, and chain saws (Paich and Sterman 1990), commercial real estate, the international oil tanker market (Bakken 1990), Sun Microsystems (Brau 1990), and others.[1]

3. Case Study: Intecom and the PBX Market

3.1 An Industry in Transition

In the early 1980s the AT&T operating companies (such as New England Telephone and New York Telephone) were converting their highly profitable base of electromechanical telephone switching systems (known as PBXs) to new electronic PBXs, in an increasingly competitive market. A key issue facing senior managers was how to retain a high share of the installed base of PBX systems while customers migrated from the old to new technology. The strategy for managing the migration required executives to think about pricing, the size, motivation and compensation of the salesforce, and the actions of competitors. In the event, some of the operating companies lost 60 percent of their market share during the migration while others lost only 20 percent!

---

[1] Contact John Sterman for additional information on these cases.

3.2 The Model and Case

A management team from one operating company commissioned a system dynamics project to help them design the migration strategy. The model (Morecroft 1984) is combined with the Intecom case (Ghemawat 1986) to replicate for students the insights gained from the project. The Intecom case deals with the entry of Intecom, a new company affiliated with Exxon, into the top-end of the US PBX market. Most of the case is devoted to describing switching products, PBX technology, customers, channels of distribution, installation, service and manufacturing. The case also provides information on competitors and deregulation. The appendices contain industry-level data on the installed base, line shipments, market shares, manufacturing costs and corporate financial performance. The case provides a wealth of background information on the industry, thereby mimicking the experience base of the AT&T management team. Students are asked to read the case in advance and think about the following questions: what is a relevant measure of market share in the PBX market, how do you set reasonable sales objectives for a migration strategy, what pricing options would you consider for old and new systems?

The case discussion lasts for three hours and is organized around three STELLA maps (Richmond *et al.* 1987) of increasing complexity that represent the migration strategy visually (figure 5). The maps are displayed on a Macintosh computer linked to a large-screen projection system. The first map shows a base of electromechanical PBXs (represented as a single stock) depleted by migration flows into a base of electronic PBXs shared between competitors and the operating company (represented as two stocks). The case teacher can use this very simple model to clarify the near-monopoly starting position of the operating companies, to trigger discussion of the changing regulatory environment and to think about market share definitions (share of base or share of sales?). He can also introduce simulation by posing a question, eliciting suggestions, and then testing those suggestions by simulating the model to answer. Thus students receive feedback on the accuracy of their mental models.

The case teacher then sets aside the computer and reverts to conventional chalk talk in order to make the class think carefully about the customers. Who are they, why should they migrate,

what factors influence their decisions, what are their motives and incentives? Here the behavioral underpinnings of system dynamics (Morecroft 1985 and 1988b, pp. 24-33; Sterman 1989a, b, and 1987) provide a checklist of suggestive questions to structure the discussion and record people's comments. The second STELLA map incorporates the main features of the chalk talk and shows explicitly how sales effort, price and customer behavior influence migration.

Class discussion next turns to the sales force. What is it like to be a systems salesperson, how might you spend your time, how do you set priorities, what motivates you? – questions that help the class probe the vital issue of the determinants of sales effort. The final step is to talk about the competition. The critical feedback process brought out here is the self-reinforcing growth of the competition (in the aggregate) as competitors use increasing sales to expand marketing efforts and develop production experience and technical know-how, thus generating still greater sales. The structured discussion lasts about two hours and leads into the third STELLA map which incorporates sales effort, price, sales time allocation, customer behavior and competitor growth.

The students are now divided into teams and sent away for half an hour to devise their own migration strategy. The "levers" they have at their disposal are price (for both old and new systems) and sales force size (a subset of the real levers available to AT&T management). Each team is given graph paper on which they can draw time profiles for price and sales force. The teams are asked to justify their choice of these policy levers and predict the likely development of market share, competitor sales, and sales expense to revenue ratio. Thus they must make explicit both their strategies and the results of their mental simulations regarding their effects, avoiding the 'video-game' mentality where participants play enthusiastically but fail to reflect upon their experience (Senge and Sterman 1991). During the remaining time as many teams as possible are given the chance to explain their customer migration strategy and to simulate it on-line in the classroom.

3.3 The Lessons

Simulations show a wide range of outcomes (Figure 6). Some teams lose market share rapidly and also incur high sales expenses. Others maintain a much higher market share with low expense to revenue ratio. This diversity resembles the outcomes of the real AT&T operating

companies. The successful teams recognized that a high lease price for the old base can be very profitable (milking the old base) but also creates vulnerability if competitors aggressively market the new technology. However, by using some of the extra funds from the old base to finance sales force expansion, competitor growth is restricted, and the expense-to-revenue ratio is reduced. Like the People Express simulator, the model deepens the level of discussion by allowing students to experience the long-term consequences of their suggested strategies.

4. Contributions of model-supported cases to management education

We turn now the contributions we expect system dynamics and computer-based case studies to make in teaching management and in development of effective systems thinking for business policy and strategy.

There seem to be at least three elements in the design of a strategy. Asking the right questions to discover the most important issues might be called *investigation.* Organizing some of the data into a new framework while downplaying other aspects is *conceptualization* or *framing.* Finally, one must select and apply past experience or an appropriate theoretical framework to help solve the current problem. Thus managers must *transfer* prior learning to the new situation. How do model-supported cases assist in investigation, conceptualization, and transfer?

4.1 Investigation / Learning Strategy

The primary contribution of model-supported case studies is creation of an environment in which investigation can occur. Morecroft (1988a) describes simulation models and model-based games as *microworlds*, which are simpler and create outcomes faster than reality, a theme developed in other domains by Schön (1983) and Papert (1980). In complex dynamic systems, such as business systems, effective investigation of cause and effect requires a model representation of the business environment in which long-term consequences can be simulated. As argued above, the traditional case method must rely on faulty mental simulations for this function.

A second contribution model supported cases can make to investigative skills is to develop skills in scientific method – hypothesis formation, experimental design, and critical evaluation of results. Computer simulations can be used to execute meaningful experiments designed to illumi-

nate the structure and dynamics of the business environment, or to search for winning strategies, with no idea as to why those strategies are effective. Many authors (Mass 1991, Senge 1990 suggest that effective learning depends on formation of a clear expectations for the behavior of key variables *before* playing, coupled with careful explanations of discrepancies between expected and actual behavior *after* playing. Indeed, participants in the Sloan School's People Express exercise are asked to state explicit predictions (hypotheses) about the effects of policies, and discuss results afterward, and "Strategy Record Sheets" are provided for the purpose, much as scientists use lab notebooks. Likewise, students in the Intecom case must specify in writing the dynamics they expect their strategies will generate before simulating them on the computer.

A third contribution of system dynamics to investigation is furnishing conceptual tools and results. System dynamics provides theory to explain how problems in complex systems arise, a language to describe them, and tools to relate system structure to behavior (Richardson and Pugh 1981, Lyneis 1980). These aid conceptualization of unfamiliar issues and often increase the effectiveness of investigation by providing a portfolio of archetypal structures which explain common system pathologies. For example, persistent cyclicality of production should prompt the analyst to seek negative feedback loops with significant delays between action and response (Sterman 1989b).

Finally, an important side effect of effective microworlds is fun. The learning process incorporates discovery, enjoyment, play, and sometimes competition. People can sustain interest in the subject matter, and the learning experience is more powerful and enduring.

4.2 Conceptualization & Abstraction

One advantage of the case study method is the real-life detail. Different types of information (numbers, descriptions, anecdotes, quotes, etc.) are mixed together. Information is available at many levels of analysis. The ability to deal with such information is critical to effective problem solving. But if the case materials have a truly realistic amount of detail, learning from the case becomes as difficult as learning from life. The primary contribution system dynamics makes to conceptualization skills is a set of well developed tools and methods for moving between detailed de-

scriptions of a situation and abstract representations. These tools include reference modes (graphs of the problematic behavior), causal loop diagrams, stock-and-flow diagrams (such as those produced by STELLA) and policy structure diagrams (Richardson and Pugh 1981, Morecroft 1982).

The People Express case handles the conceptualization and abstraction process through a series of transitions from the detailed to the abstract: It begins with the written case (rich in detail, but little theory), moves to the briefing book (almost as rich in detail, but organized to show cause-and-effect structure more clearly), and then immerses learners in the simulation game (in which players control only a subset of the policy levers available to the real managers). The instructor may then analyze simulations (where decisions are replaced by decision rules and examination of the state of affairs at particular points in time is replaced by examination of system behavior over time), and finally, discuss behavioral principles.

The Intecom PBX case similarly uses a series of transitions, beginning with the detail-rich case and moving through stock and flow diagrams and policy structure diagrams that focus discussion on customer, sales force and competitor behavior. The process likewise moves from the specific to the general: from small group discussion of migration strategy, to instructor-led consideration of simulations, and finally strategic lessons which relate simulated behavior to system structure. Recent experiments to involve management teams in conceptualization and model-based learning have also made specific use of transitions using conceptualization tools – moving from loosely structured discussion, to mapping, "friendly algebra" and ultimately simulation (Morecroft, Lane and Viita 1989, Senge 1990).

4.3 Theory Application / Transfer Skills

Cases are taught not as exercises in historical analysis but so students may learn general principles applicable to new situations. Students must somehow extract general lessons from the cases they study and transfer them appropriately to problems they face as managers. Prior research suggests transfer of concepts from one situation to another is difficult, though some are more optimistic than others (Nisbett et al. 1987). A large literature suggests the traditional case method is not well suited to teaching systemic thinking and the ability to transfer insights from one problem

to another (Kardes 1987, Nisbett et al. 1987, Bakken, Gould, and Kim 1991).

Both the People Express and Intecom workshops are designed to emphasize the applicability of the insights gained to other industries or firms. System dynamics provides tools which facilitate appropriate transfer of management insights. It emphasizes the importance of transfer and trains people to recognize the archetypal structures which explain common patterns of dynamic behavior in diverse systems (Graham 1977, 1988, Paich 1985). Just as the Porter or BCG frameworks supply generic strategies and structures which can be applied to a variety of different situations, the generic structures identified in system dynamics provide the student with interrelated templates they can transfer to actual cases. The conceptualization and analysis skills taught in system dynamics aid people in the prospective design of strategy by providing tools to highlight problematic patterns of dynamics, diagnose causes by identifying the generic feedback processes at work, and transfer insight about effective policies from these archetypal situations into the particular case.

5. Evaluating the effectiveness of model-supported cases

Are model-supported cases studies effective in teaching principles of business strategy analysis and systems thinking? Are they more effective than other methods? The closest analog to the model-supported cases described here are traditional management games. The purpose, protocols for, and technologies used in these games differ in significant ways from the model-supported case method presented here. Nevertheless, it is instructive that the literature on the effectiveness of management games paints a decidedly mixed picture. While many studies report favorable effects of games compared to traditional methods, others argue that games have no beneficial effect. Wheatley, Hornaday, & Hunt (1988), for example, found that students enjoy standard management games but argue that performance in the classroom and later life is not enhanced by games.

A key finding emerging from this literature is that game play alone is not sufficient for lasting learning. Neuhauser (1976) argues that the value of games comes from the process of building the model used in the game; thus the game designers find them interesting and useful while the learners who merely play the games may become bored and disenchanted. Toval and

Flores (1987) make the same claim, and argue it is the process of model-building which generates deep knowledge of the systems under study. Certainly this is the experience of professional model builders. Indeed, what emerges from the People Express, Intecom, and other model-supported cases is that learning comes from the full model-building experience, not primarily from simulation or game play. By model-building experience is meant the full range of conceptualization, formulation, and testing which goes on whether one employs a formal simulation or mental model. The People Express, Intecom, and other model-supported cases developed using system dynamics were explicitly designed to promote such modeling. Thus the negative results of many evaluations of prior management games do not apply. New evaluations of effectiveness are needed. Work on measurement methods is progressing in several projects. A number of evaluative studies are under way at MIT, including both students in the classroom and managers in organizations (Moissis 1989, Bakken 1989, Bakken, Gould, and Kim 1991). The Educational Testing Service is currently attempting to define metrics for systems thinking to evaluate the effectiveness of system dynamics in high school curricula including physics, chemistry, and social studies (Mandinach and Cline 1990). Pilot programs are underway in several school districts in the United States.

6. Conclusion

Effective management education is important to individuals, corporations, educational institutions, and ultimately, society in general. The preceding discussion strongly suggests that considerable improvement is available in management education. Computer-based case studies – models-with-cases – seem to offer considerable potential.

Moving forward with model-supported case studies will require collaboration among numerous stakeholders: Corporations and managers to fund, to serve as test sites for, and in some instances, to be final users of model supported cases. Modelers and researchers are needed to create the cases and do the painstaking measurement necessary to establish their effectiveness. Universities must provide institutional support for research into management education and for integrating model-supported cases into the curriculum. The need is pressing; the prototypes already developed in universities and the private sector suggest the feasibility of the approach.

References

Bakken, B. (1990), "Transfer of learning in cyclical markets: An experimental approach", Working paper D-4166, System Dynamics Group, Sloan School of Management, MIT, Cambridge MA 02139.

Bakken, B. (1989), "Learning in dynamic simulation games: Using performance as a measure", in: P. Milling and E. Zahn (eds), *Computer Based Management of Complex Systems,* Berlin: Springer Verlag, 309-316.

Bakken, B., J. Gould, D. Kim (1991), "Experimentation in Learning Organizations: A Management Flight Simulator Approach" *European Journal of Operational Research,* forthcoming.

Brau, K. (1990), "A Computer-Based Case Study of Sun MicroSystems", MS Thesis, MIT Sloan School of Management, Cambridge, MA.

Brehmer, B. (1990), "Strategies in real-time, dynamic decision making", in: R. Hogarth (ed.), *Insights in Decision Making,* Chicago: University of Chicago Press, 262-279.

Diehl, E. W. (1989), "A study of human control in stock-adjustment tasks", in: P. Milling. and E. Zahn (eds), *Computer Based Management of Complex Systems,* Berlin: Springer Verlag, 205-212.

Graham, A. (1988), "Generic models as a basis for computer-based case studies", *Proceedings of the 1988 International System Dynamics Conference*, La Jolla, California. Also available as MIT System Dynamics Group Working Paper D-3947.

Graham, A. (1977), "Principles on the Relationship between Structure and Behavior of Dynamic Systems". Ph.D. Thesis, Department of Electrical Engineering and Computer Science, MIT, Cambridge, MA.

Ghemawat, P. (1986), "Intecom teaching note", Case Teaching Note 5-386-109, HBS Case Services, Boston MA 02163-1098.

Harvard Business School (1985), "People Express: Don Burr, Chairman and CEO, question and answer session with an MBA class", Video Tape 885-516, HBS Case Services, Boston MA 02163-1098.

Hax, A.C. and Majluf, N.S. (1984), *Strategic Management: An Integrated Perspective,* Englewood Cliffs, N.J.: Prentice-Hall.

Holland, P., and Beer, M. (1990), "People express airlines: Rise and decline", N9-490-012. HBS Case Services, Boston MA 02163-1098.

Hogarth, R. (1987), *Judgement and Choice, 2nd Edition,* Chichester: John Wiley.

Kahneman, D., Slovic, P., and Tversky, A. (1982), *Judgment Under Uncertainty Heuristics and Biases,* Cambridge University Press, Cambridge.

Kardes, F. (1987), "The case method of instruction and managerial decision making", Cambridge, MA.: MIT Sloan School of Management Working Paper.

Kleinmuntz, D. (1985), "Cognitive heuristics and feedback in a dynamic decision environment", *Management Science* 31(6), 680-702.

Lyneis, J. (1980), *Corporate planning and policy design*, Cambridge: The MIT Press.

Mandinach, E., and Cline, H. (1990), "Systems, science, and schools", *Proceedings of the 1990 International System Dynamics Conference*, 729-741.

Mass, N. (1991), "Diagnosing surprise model behavior", *System Dynamics Review* 7(1).

Merten, P., Löffler, R., & Wiedmann, K. P. (1987), "Portfolio simulation: A tool to support strategic management", *System Dynamics Review* 3(2), 81-101.

Moissis, A. (1989), "Decision Making in the Insurance Industry: A Dynamic Simulation Model and Experimental Results" Cambridge, Mass.: MIT Sloan School of Management MS Thesis.

Morecroft, J. (1988b), "Executive knowledge, models and strategic change", London, U.K.: London Business School Discussion Paper GS-24-87, September 1988.

Morecroft, J. (1988a), "System dynamics and microworlds for policymakers", *European Journal of Operational Research* 35(5), 301-320.

Morecroft, J. (1985), "Rationality in the analysis of behavioral simulation models", *Management Science* 31(7), 900-916.

Morecroft, J. (1984), "Strategy support models", *Strategic Management Journal* 5(3), 215-229.

Morecroft, J. (1982), "A critical review of diagraming tools for conceptualizing feedback system models", *Dynamica* 8, 20-29.

Morecroft, J., Lane, D.C. and Viita, P.S. (1989), "Modelling growth strategy in a biotechnology startup firm", London Business School, GS 53289. Also available as MIT System Dynamics Group Working Paper D-4150.

Neuhauser, J. (1976), "Business games have failed", *Academy of Management Review* 1(4), 124-129.

Nisbett, R., et al. (1987), "Teaching reasoning", *Science*, 238(30), 625-631.

Paich, M. (1985), "Generic structures", *System Dynamics Review* 1, 126-132.

Paich, M. and Sterman, J. (1990), "Riding the rollercoaster: Dynamic decision making in corporate strategy", presented at the Conference on Behavioral Decision-Making Research in Management, The Wharton School, June 1-2.

Papert, S. (1980), *Mindstorms.*, New York, Basic Books.

Porter, M. (1985), *Competitive Advantage*, New York, NY: The Free Press.

Porter, M. (1980), *Competitive Strategy*, New York, NY: The Free Press.

Richardson, G. P. and Pugh, A. (1981), *Introduction to System Dynamics Modeling With DYNAMO,* Cambridge: The MIT Press.

Richmond, B., Vescuso, P. and Peterson, S. (1987), *STELLA for Business.*, Distributed by High Performance Systems, 45 Lyme Road, Hanover, NH 03755.

Schön, D. (1983), *The Reflective Practitioner*, New York: Basic Books.

Senge, P. (1990), "Catalyzing systems thinking in organizations." in: F. Massaryk (ed.), *Advances in Organization Development* , Norwood, NJ: Ablex, 197-246.

Senge, P. and Sterman, J. (1991), "Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future", *European Journal of Operational Research*, forthcoming.

Simon, H. A. (1979), "Rational decision-making in business organizations", *American Economic Review* 69, 493-513.

Sterman, J. (1989b), "Modeling managerial behavior: misperceptions of feedback in a dynamic decision making experiment", *Management Science* 35(3), 321-339.

Sterman, J. (1989a), "Misperceptions of feedback in dynamic decision making", *Organizational Behavior and Human Decision Processes* 43(3), 301-335.

Sterman, J. (1988), "People express management flight simulator", software and documentation available from J. Sterman, E52-562, Sloan School of Management, Cambridge, MA 02139.

Sterman, J. D. (1987), "Testing behavioral simulation models by direct experiment", *Management Science* 33 (12), 1572-1592.

Toval, A. and Flores, M. (1987), "Computer systems simulation in education: description of an experience", *Computers and Education* 11(4), 293-303.

Wheatley, W., Hornaday, R., and Hunt, T. (1988), "Developing strategic management goal-setting skills", *Simulation and Games* 19(2), 173-185.

Whitestone, D. (1983), "People express (A)", Cambridge, Mass: HBS Case Services, #483-103.

Table 1. History of People Express Airlines (Sterman 1988).

April '81	Service Begins
March '83	Fleet of 20 grows to 40 aircraft
May '83	Expansion: Service to London
July '85	2nd Quarter profits of $13 Million
October '85	Frontier purchased for $307 M
December '85	Britt Airways purchased
February '86	Record loss $32 M in 4th Q 85
May '86	Loss of $58 M in 1st Q 1986
	Approval to buy PBA
June '86	Deep fare cuts
	Don Burr puts PE up for sale
July '86	Texas Air offers $314 million
	UAL offers $146 for Frontier
August '86	UAL deal falls through
	Frontier files Chapter 11
September 15, 1986:	PE sold to Texas Air for $125 Million

Figure 1. Rise and Fall of People Express Airlines (Holland and Beer 1990).

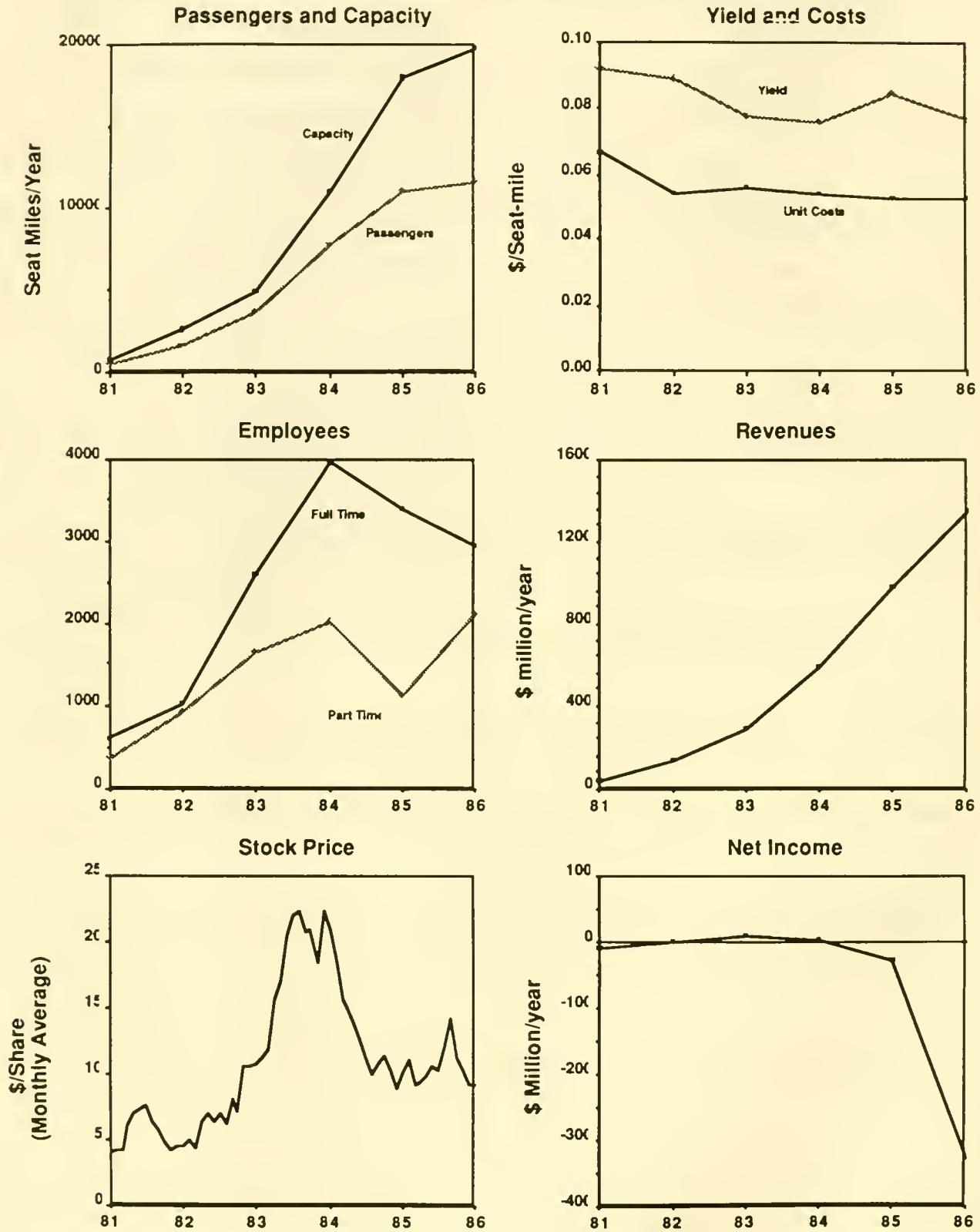


Figure 2. Overview of the People Express Management Flight Simulator (Sterman 1988).

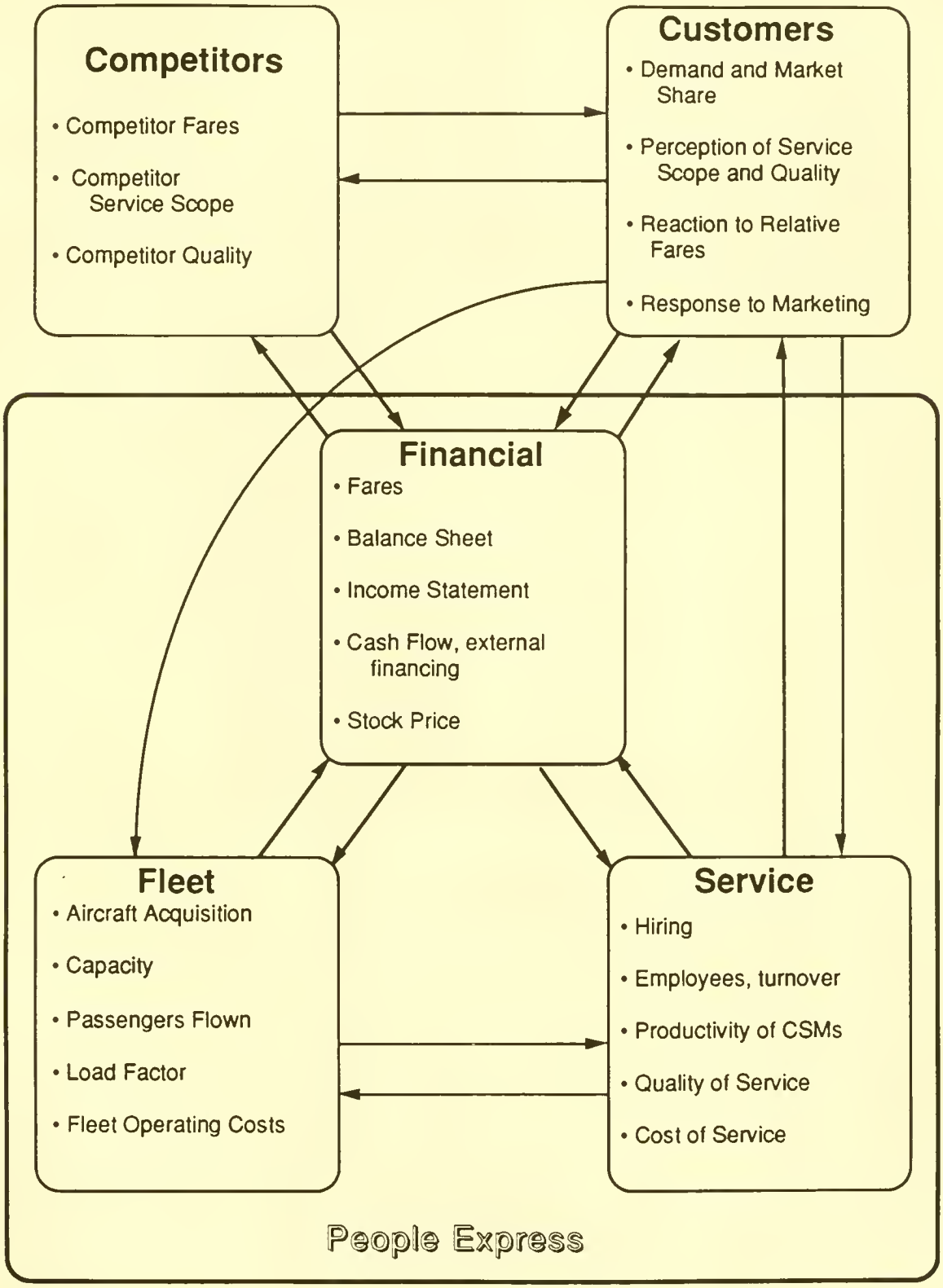


Figure 3. Typical screen from the People Express Management Flight Simulator.

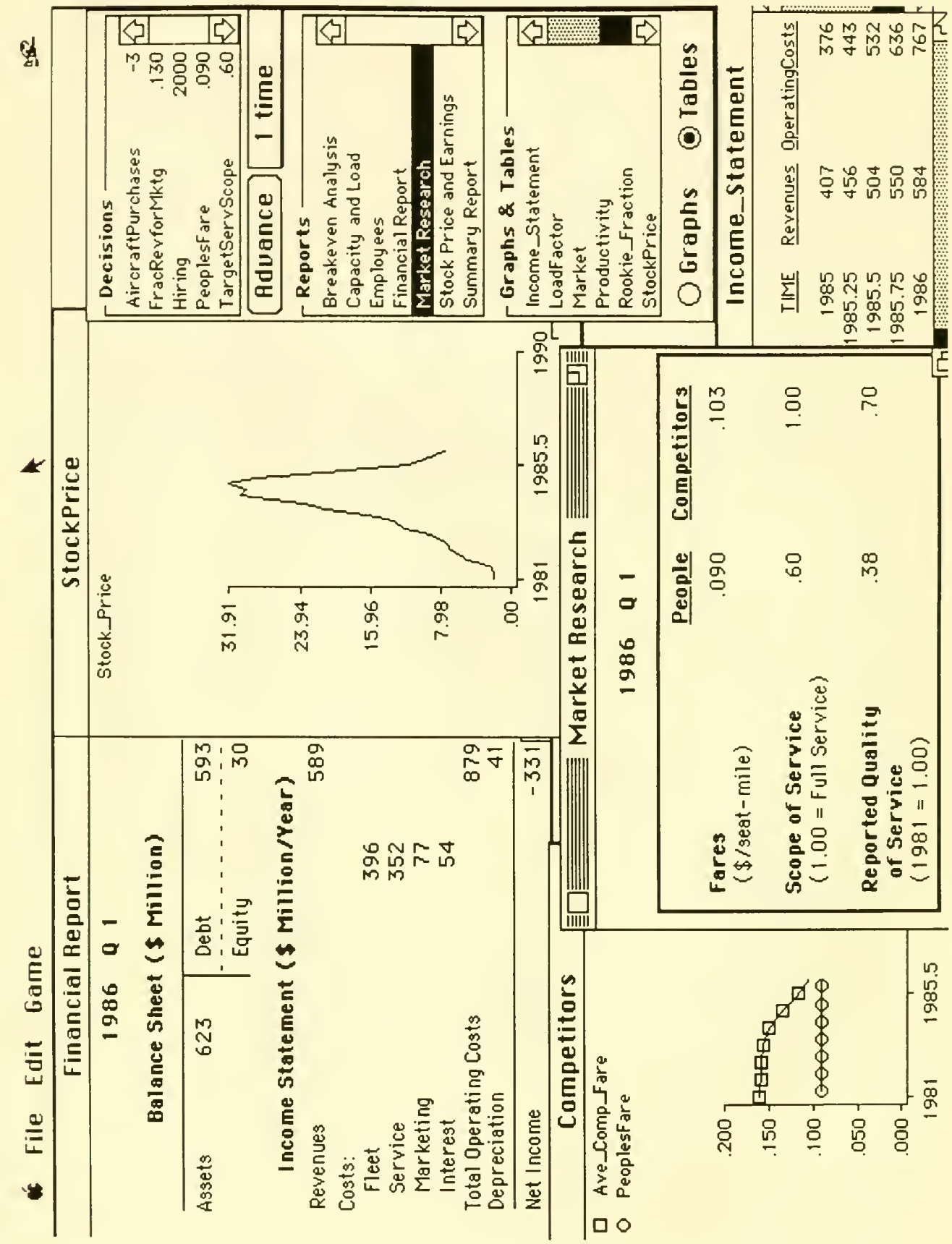


Figure 4. Student Evaluations of People Express Management Flight Simulator as used in the orientation workshop for the incoming master's class at the Sloan School of Management, MIT, September 1988.

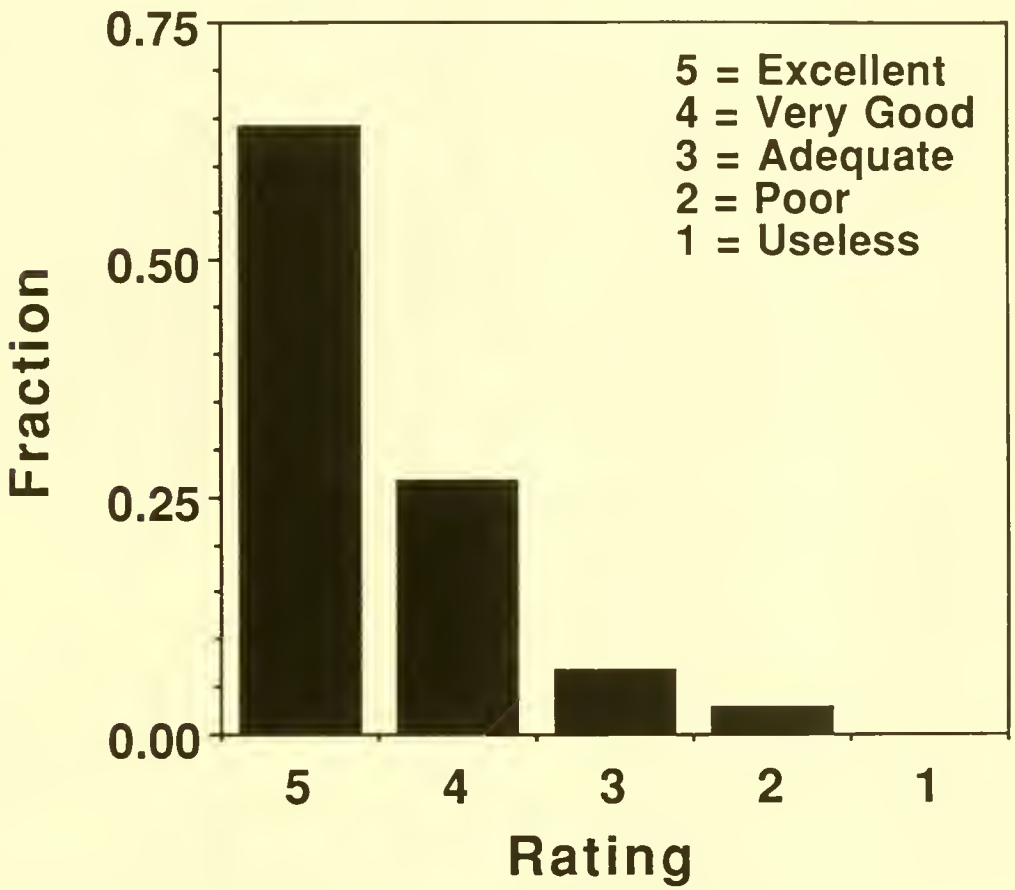


Figure 5. STELLA map of PBX migration problem, showing migration flows from base of leased electromechanical systems to purchased, electronic systems, divided between the firm and the competition. Decision structure focuses on the strategy of the competitors and the allocation of the firm's salesforce effort between proactive and reactive selling.

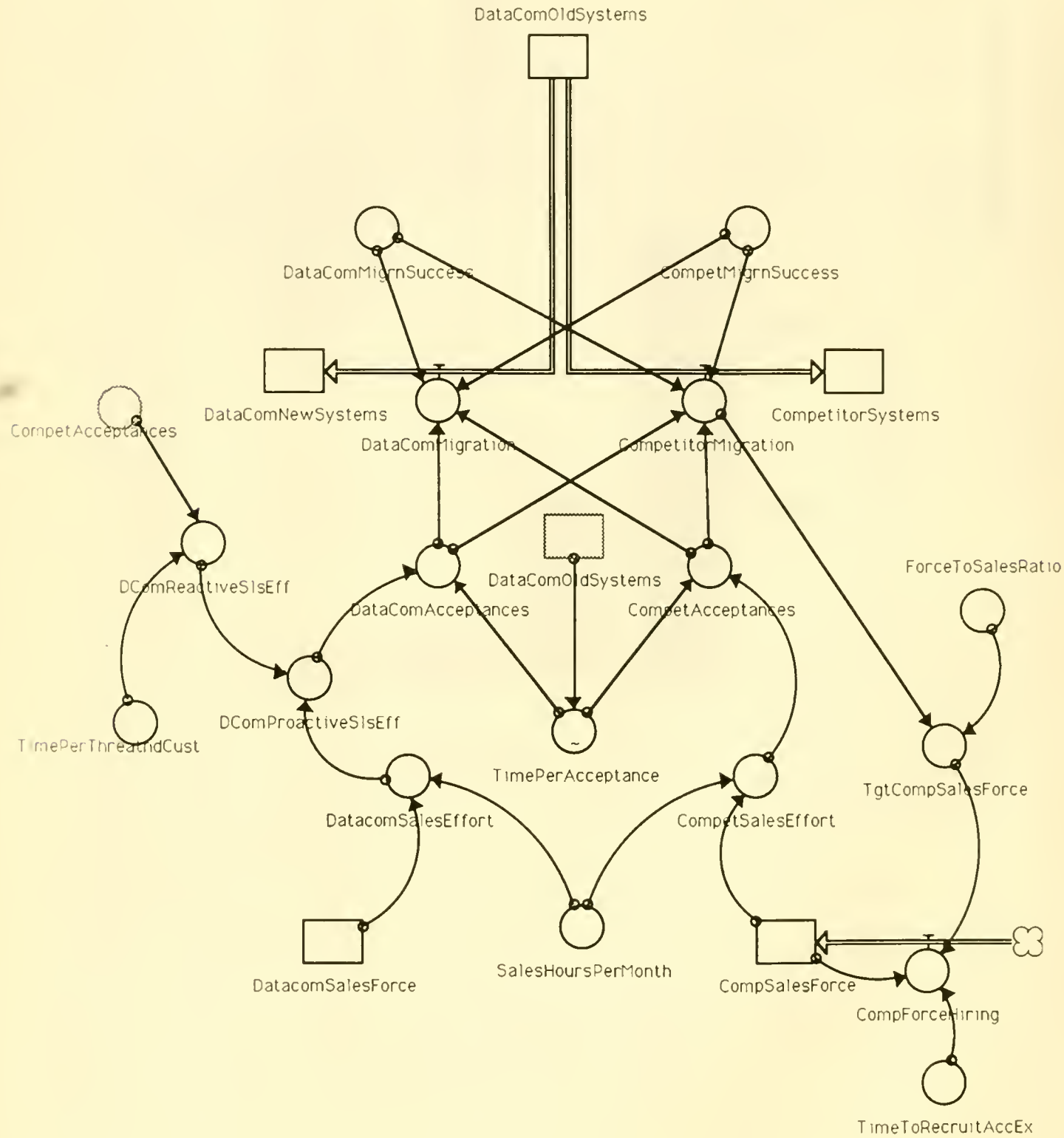
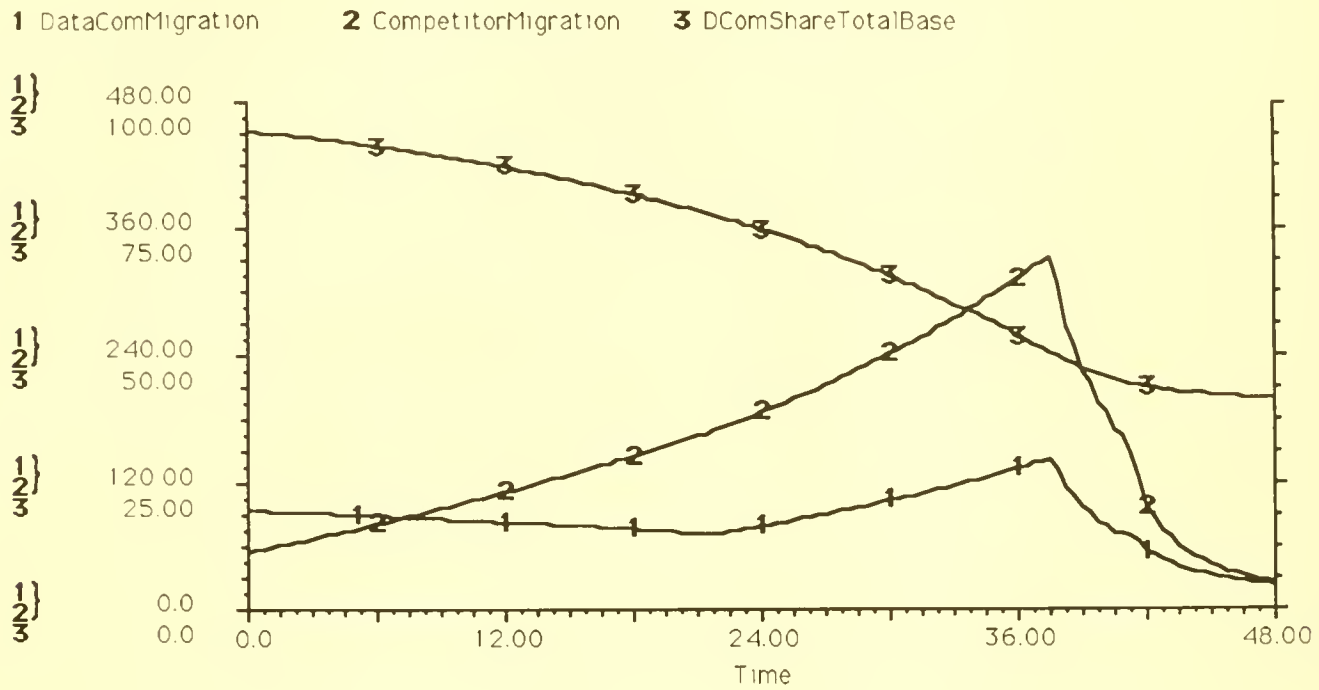
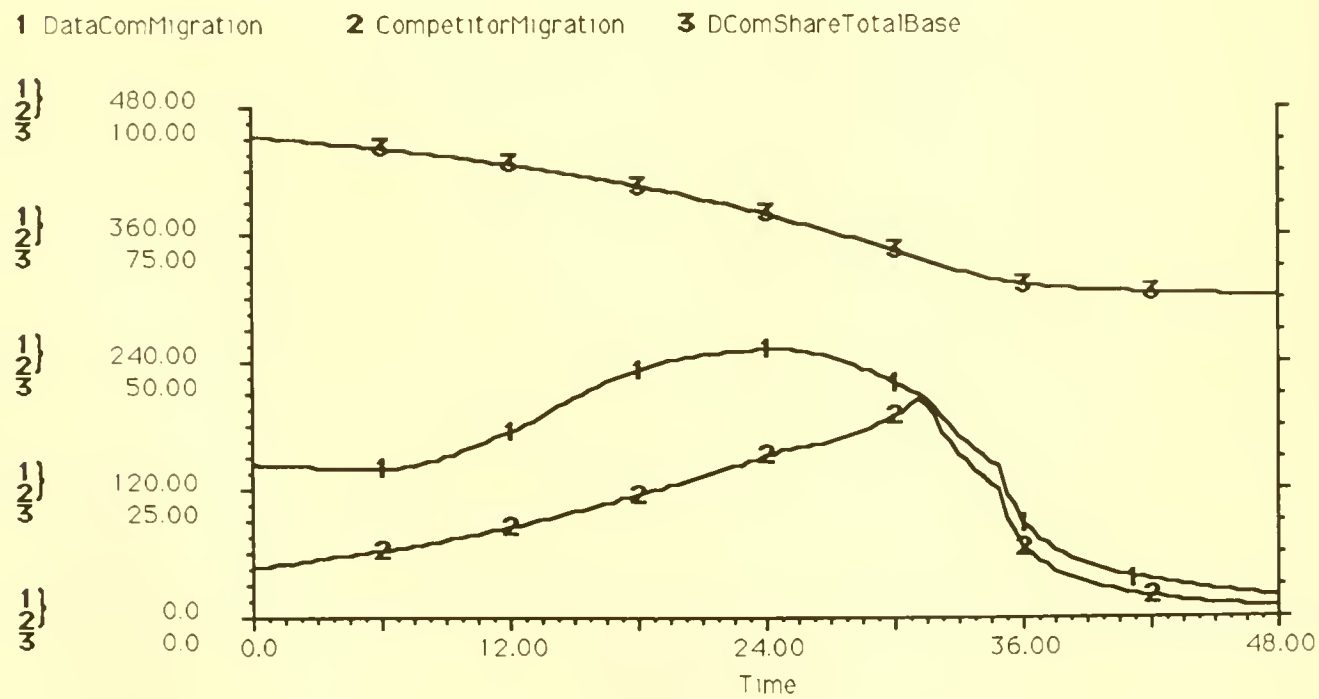


Figure 6. Simulations of PBX model. Variable 1: Migration rate from leased base to firm. Variable 2: Migration to competitor. Variable 3: Firm's share of installed base. Top: Firm's share of installed base falls under 50% when firm tries to retain profitable lease-base customers; conversion effort of highly stressed salesforce is primarily defensive. Bottom: Firm retains a higher share when it expands sales force and seeks early conversion of existing customers to new systems, slowing competitor growth.





4400 097

Date Due

Lib-26-67

MIT LIBRARIES DUPL

3 9080 00701522 2